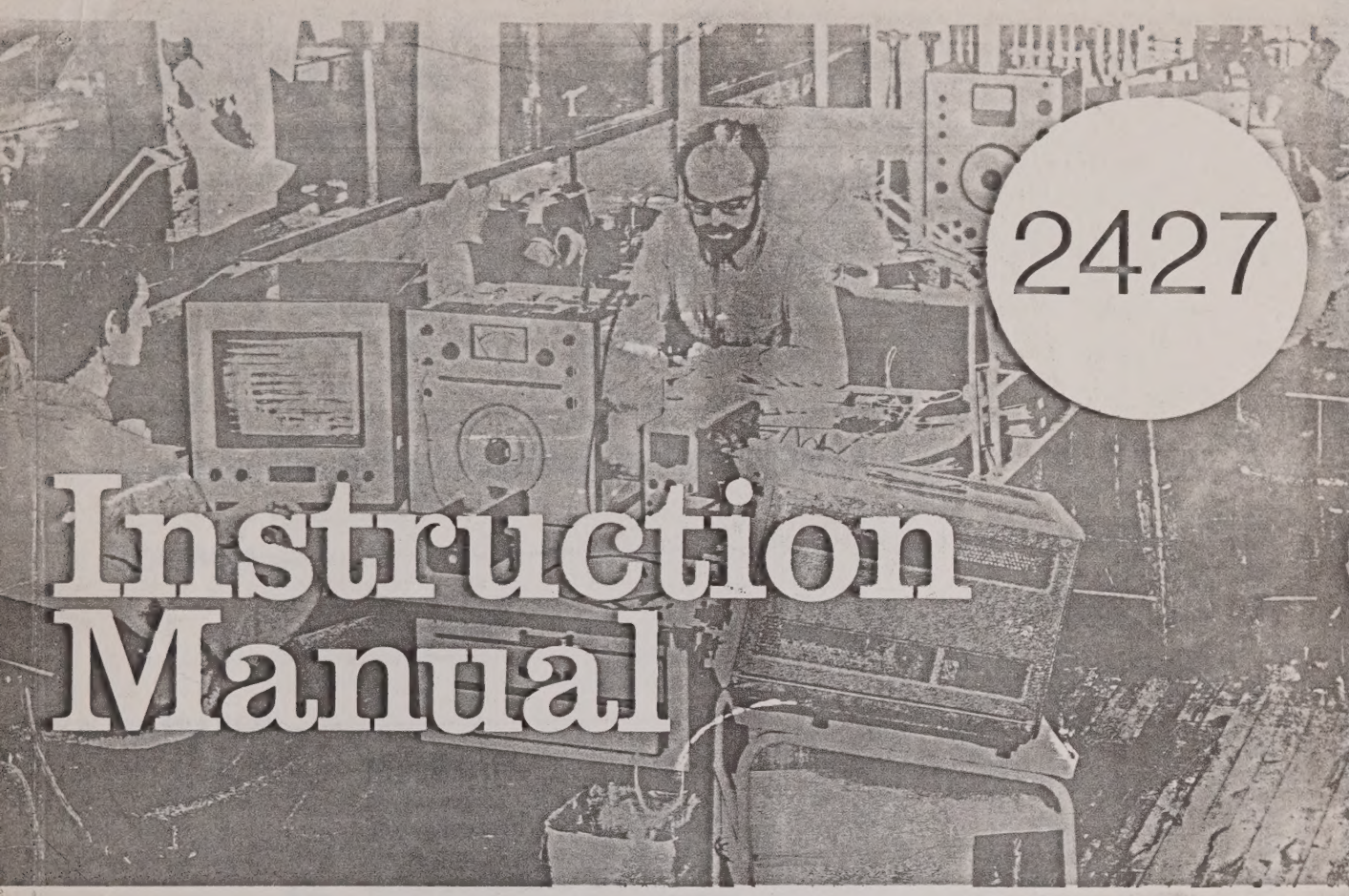
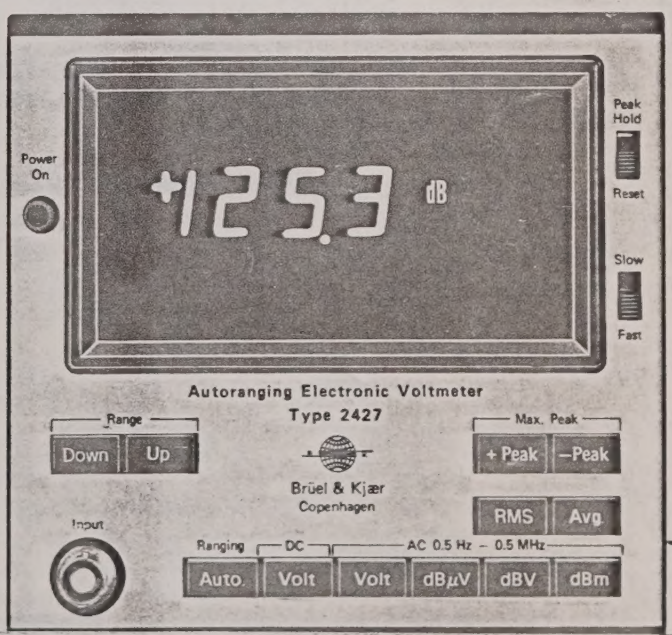


2427

Instruction Manual



Autoranging Electronic Voltmeter Type 2427

A digital display voltmeter giving true RMS, Average, and Peak indication of AC signals in the 0,5 Hz to 500 kHz range and DC voltage up to 400 V. Autoranging circuitry selects the correct range from 1,00 mV to 1000 V. Direct display of the voltage in dBm, dBV, or dB μV is also provided. A digital output permits connection to digital data receivers.

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MANUAL # 2

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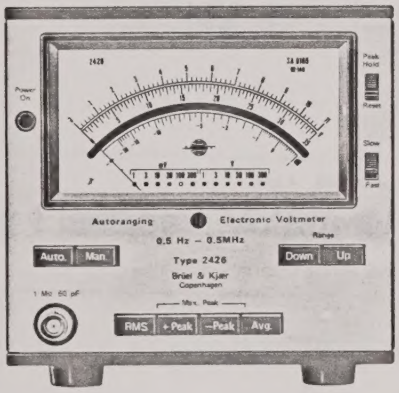
types 2425, 2426 and 2427

Electronic Voltmeters

2425



2426

2427

COMMON FEATURES:

- True RMS detector with 40 dB range
- Crest Factor of 5
- Average detector
- + Peak, —Peak and Max. Peak detectors, rise time 50 μs
- Peak Hold function
- Wide frequency range 0,5 Hz to 0,5 MHz
- Indication of Volts, dBV and dBm
- Two built-in meter time constants
- Sensitivities from 1 mV to 300 V FSD
- Calibrated amplifier
- AC and DC outputs
- External meter time constants

ADDITIONAL FEATURES 2425:

- Conformity to VU-meter standards
- Battery operation

ADDITIONAL FEATURES 2426:

- Automatic range selection
- Range indicator lamps
- Binary input for external range control
- Conformity to VU-meter standards

ADDITIONAL FEATURES 2427:

- 3 1/2 digit display
- BCD output of reading
- DC range from 100 mV to 400 V with indication of sign
- Automatic range selection
- Variable display rate

USES:

- Voltage measurement of —Peak, + Peak, Max. Peak, true RMS and Average values
- Calibrated amplifier
- General purpose EVM
- VU measurements (2425 and 2426 only)

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The Electronic Voltmeters Types 2425, 2426 and 2427 are compact, general purpose voltmeters which all provide the same basic functions with similar specifications. The voltmeters all contain a true RMS rectifier with a dynamic range of 40 dB and a crest factor capability of 5 (14 dB) permitting measurement of complex, distorted or phase shifted signals. They also contain an average detector which gives the instruments (2425 and 2426 only) conformity to the standards for VU measurements. For the measurement of impulsive signals, a peak detector is included. It has three modes permitting detection of either positive or negative peaks as short as 50 μs or the greater of the two values, the max. peak. In connection with the peak detector, a hold circuit may be incorporated in order to hold the value of the signal after it has disappeared from the input.

The voltmeters feature a wide frequency range, 0,5 Hz to 0,5 MHz, and operate with fixed gain amplifiers in order to assure constant phase characteristics in all ranges.

AC as well as DC outputs are available permitting the instruments to be used as calibrated amplifiers. The outputs are well suited for the connection of level recorders.

Type 2425 Electronic Voltmeter

The Type 2425 is an AC voltmeter with manual operation. The ranges are selected by means of push-buttons arranged in 10 dB steps over a 110 dB range from 1 mV to 300 V. Interchangeable scales are available for the measurement of dBm and VU. The instrument may be operated from an external battery supply as well as from the mains.

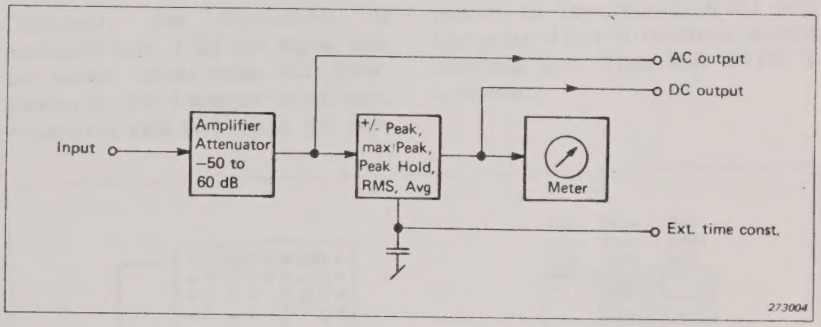

Fig.1. Block diagram of Type 2425

Type 2426 Autoranging Electronic Voltmeter

The Type 2426 is identical to the Type 2425 in functions and specifications but is further equipped with an automatic range selector which makes is extremely easy to operate. It consists of a Man./Auto mode selector, a Down/Up range shift circuit, a Comparator and Logic circuit, a Down/Up counter which provides a Binary signal representing the chosen range (available at the Binary range information socket), a Range Indicator circuit which drives range indicator lamps mounted in the meter, and a Relay Control circuit which controls the amplifier section and thereby the chosen range. The automatic range shift occurs at a higher voltage when the range is shifted upwards than when it is shifted downwards (hysteresis). This prevents instability at the points of range change. The range may also be set manually if the measuring signal is very unstable, or it may be set by means of an external digital control signal thus permitting remote control of the instrument, for example when used as a calibrated amplifier.

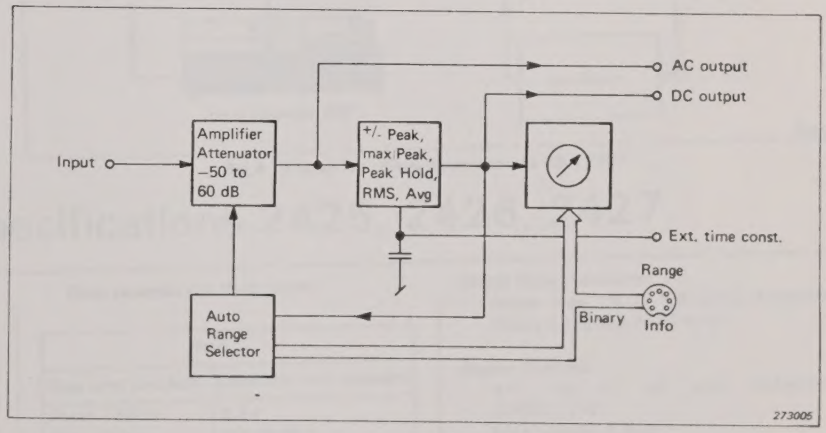

Fig.2. Block diagram of Type 2426

Type 2427 Autoranging Digital Voltmeter

The Type 2427 is similar to the Types 2425 and 2426 in their basic functions but is by far the most sophisticated, using extensive TTL logic and ROMs. It is equipped with a seven segment, digital display which simplifies reading by displaying proper sign, measuring units, decimal point as well as providing out of range indication. The instrument can display the measured value in Volts, dBV (ref. 1 V), dBm (ref. 0,775 V) or dB μV (ref. 1 μV). The conversion to decibels is performed by purely digital means by

use of a ROM containing the dB values. Errors due to drift and offset, inherent in analog lin/log converters, is thus eliminated. The A/D converter is an integrating type giving high accuracy and an excellent normal mode rejection of 60 dB in the 2 lower ranges and 80 dB in the 3 upper ranges. The autoranging circuit is extremely stable as the range steps are 20 dB and the hysteresis is 4 dB for AC signals and 10 dB for DC signals. The 2427 has 5 DC ranges from 100,0 mV to 400 V.

The reading rate of the instrument can be adjusted between 2 to 10 readings per second. The reading may also be frozen at any given instant via a rear panel socket.

For interfacing to a Tape Punch or Computer, the instrument is equipped with a 25 pin digital output socket which holds BCD information on the displayed value, sign, measuring unit and range. For connection to Tape Punch 6301 and Computer 7504 a relatively simple interface unit, Type WA 0122 is available.

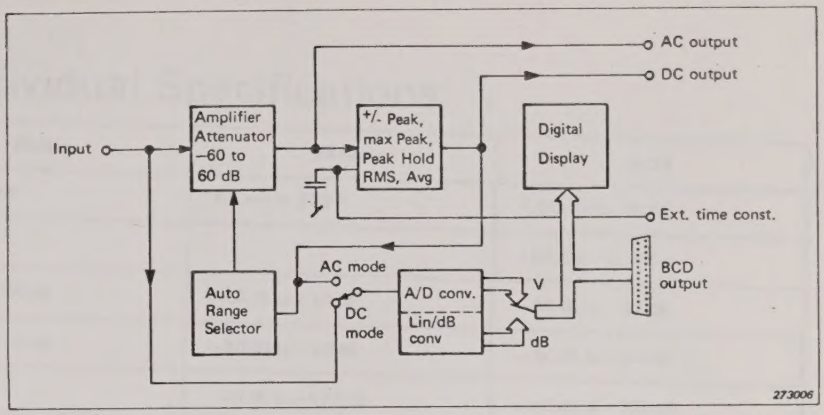

Fig.3. Block diagram of Type 2427

Examples of Use

As can be seen in Fig.4, the voltmeters may be combined with the Phase Meter Type 2971 to form a set-up for phase measurement.

The combination features automatic range selection according to the levels of the ingoing signals giving an actual dynamic range of 120 dB, a frequency range of 2 Hz to 200 kHz, no necessity for tuning, high noise immunity (down to a signal/noise ratio of 3 dB in some cases) and digital and analog readout in degrees and radians.

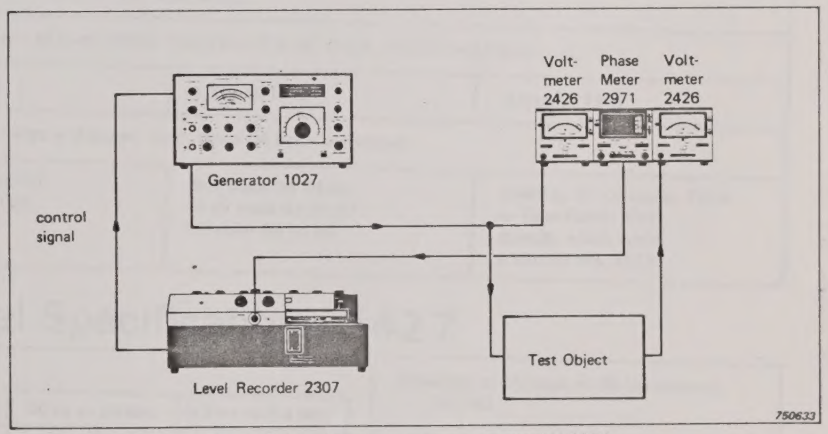

Fig.4. Set-up for phase measurement with 2971

Common Specifications 2425, 2426, 2427

Frequency Range:

	0,5 Hz	2 Hz	20 Hz	0,2 MHz	0,5
Fast			± 0,2 dB	± 0,5 dB	
Slow	± 0,5 dB	± 0,2 dB		± 0,5 dB	

Rectifier Characteristics:
(Also valid for DC output)
Dynamic range: > 40 dB
Accuracy: + 10 dB to —20 dB: ± 0,5 dB
—20 dB to —30 dB: ± 1 dB

Indication:
RMS: Reading within ± 0,5 dB of signals with crest factors up to 5
Averaging time: fast: ~ 270 ms
slow: ~ 3 s
External capacitor: 1 s per 2,5 µF

Peak: + Peak, —Peak, Max. Peak and Peak Hold Function selectable on front panel

Time constants in Peak mode:

Fast	
Rise time constant	Discharge time constant
Reset < 50 µs Hold < 50 µs	2,7 s < 0,05 dB/s
Slow	
Reset < 500 µs Hold < 500 µs	30 s < 0,005 dB/s

External time constant and rise time via socket on rear panel
Reset Function: Internal by switch on front panel or external via socket on rear panel
Average: Fast (according to standards for VU measurements 2425 and 2426 only) and Slow

Attenuator Accuracy:
Better than 1%

Meter Scale Accuracy:
Better than 1% of full scale deflection (Types 2425 and 2426 only)

Signal Outputs:
1 V ± 2% for full scale deflection (2426:1,1 V)
Max. output: 5,6 Vp
Output Impedance AC: ~ 100 Ω
Min. load impedance: 10 kΩ//200 pF
Output Impedance DC: ~ 10 Ω
Min. load impedance: 1 kΩ

Signal to Noise Ratio: (Ref. 3,16 V RMS)
Range 10 mV to 1000 V: > 60 dB
Range 3 mV: > 50 dB
Range 1 mV: > 40 dB

Inherent Noise:
31,6 µV (typical with max. amplification and input short circuited)

Temperature Range:
5 to 40°C (41 to 104°F)

Individual Specifications

Type number	2425	2426	2427
Voltage range AC*	1 mV to 300 V	1,1 mV to 350 V	1,00 mV to 380 V
Voltage Range DC*	—	—	100,0 mV to 400 V
dB Range (ref. 1 V)*	—60 dB to + 50 dB	—59 dB to + 51 dB	—60 dB to + 52 dB
dBm Range (ref. 0,775 V)*	—60 dB to + 52 dB	—60 dB to + 53 dB	—60 dB to + 54 dB
dB Range (ref. 1 μV)*	—	+ 60 dB to + 171 dB	+ 60 dB to + 172 dB
Input Impedance AC	1 MΩ//47 pF	1 MΩ//60 pF	1 MΩ//70 pF
Amplification	+ 60 dB to —50 dB (in 10 dB steps)	+ 60 dB to —50 dB (in 10 dB steps)	+ 60 dB to —60 dB (in 20 dB steps)
Power Supply	100 V to 240 V AC ± 10%, 50 Hz to 400 Hz 2 × 22 V to 35 V DC	100 V to 240 V AC ± 10%, 50 Hz to 400 Hz	100 V to 240 V AC ± 10%, 50 Hz to 400 Hz
Cabinet	KK 0024, 4/12 of standard 19" rack width		
Dimensions	Height: 132,6 mm (5,2 in) Width: 139,5 mm (5,5 in) Depth: 200,0 mm (7,9 in)		
Weight	2,1 kg (4,7 lbs)	2,3 kg (5,1 lbs)	3,0 kg (6,7 lbs)
Accessories Included	Various fuses, lamps and power cord. Plugs for input and output		
Accessories Available	dBm scale SA 0163 VU scale SA 0168	dBm scale SA 0166 dB μV scale SA 0171 VU scale SA 0169	Interface for Computer 7504 or Tape Punch 6301 (specify which when ordering) WA 0122

* Full scale deflection

Special Specifications 2427

AC Characteristics — Accuracy:

Function	Range	1 kHz		20 Hz to 20 kHz		0,5 Hz to 0,5 MHZ	
		% of reading	% of range	% of reading	% of range	% of reading	% of range
RMS and Average	1,00 mV	1%	0,5%	3%	0,5%	6%	1%
	10,00 mV to 1000 V*	1%	0,5%	2%	0,5%	4%	0,8%
+ Peak —Peak	1,00 mV	1%	**10%	3%	**10%	6%	**10%
Max. Peak	10,00 mV to 1000 V*	1%	1%	2%	1%	4%	1,5%

* max. input voltage 380 V (sine value)
** Peak noise = 10% of range = 100 μV

DC Characteristics:

Range	Accuracy		Input resistance	Typical values	
	% of reading	% of range		Normal mode rejection**	Max. normal mode voltage**
100,0 mV	0,3%	0,5%	1 MΩ	60 dB	12 V pk
1000 mV	0,3%	0,2%	1 MΩ	60 dB	12 V pk
10,00 V	0,3%	0,2%	10 MΩ	80 dB	200 V pk
100,0 V	0,3%	0,2%	10 MΩ	80 dB	400 V pk
1000 V	0,3%	0,2%	10 MΩ	80 dB	400 V pk

* max. DC input voltage = 400 V
** at 50 Hz

Accuracy of Voltage to dB conversion:
± 0,1 dB

Reading Rate:
2 to 10 readings/s

Digital Output:
Signal level: 8-4-2-1 BCD — 13 bits total
Range information: 4-2-1 BCD signal
Sign: + or —
Out of range
Data transfer
Data hold
All outputs TTL compatible, can drive at least four TTL loads

2. CONTROLS

2.1. FRONT PANEL

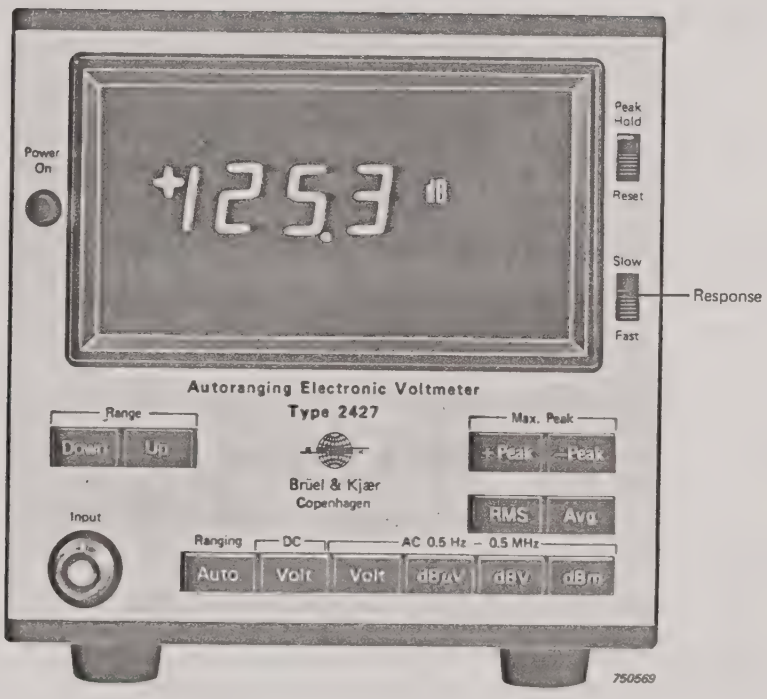

Fig.2.1. Front panel

POWER:

Power is on with the switch "in" and off with the switch "out". The digital display lights when power is on. Before switching on, check that the voltage is set to the correct mains voltage (see section 2.2).

DISPLAY:

Directly indicates the digital value of the voltage being measured. Indicates correct sign, decimal point position and units being measured. The "Out of Range" lamp flashes when the input signal is too high or too low for the range used.

INPUT:

BNC socket for connection of voltage to be measured, either AC or DC. For AC measurements the input impedance is 1 MΩ//60 pF. For DC, the input resistance is 1 MΩ in the 100,0 mV and 1000 mV ranges and 10 MΩ in the 10 V to 1000 V ranges.

Maximum input voltages: 380 VAC RMS (600 V peak) and 400 VDC.

Caution: The 2427 must not be used for floating ground measurements. There must not be a voltage on the negative input lead to the 2427 with respect to true earth ground.

RANGING:

With the "Auto" switch depressed, the 2427 automatically selects the correct range.

With the "Auto" switch out, the range is manually selected using the "Up" and "Down" RANGE switches. The RANGE switches must be pushed once for every range shift of 20 dB. AC ranges go from 1 mV to 1000 V and DC ranges from 100 mV to 1000 V. See Fig.3.2.

DC VOLT:

Selects the DC voltage mode. Either positive or negative signals may be applied since the 2427 automatically determines polarity.

The remainder of the front panel controls only function with the AC VOLT switch depressed.

dBμV:

Gives the level of the input voltage in dB above 1 μV.

dBV:

Gives the level of the input voltage in dB referenced to 1 V.

dBm:

Gives the level of the input voltage in dB re 0,775 V RMS. The 2427 does not provide a 600 Ω termination normally required for dBm measurements.

RMS:

Selects true RMS detection of the AC signal.

Avg.:

Gives average signal detection.

+ Peak:

Gives value of positive peaks.

—Peak:

Gives value of negative peaks.

Max. Peak:

Gives higher of positive and negative peak values when both "+ Peak" and "—Peak" are depressed.

RESPONSE:

"Fast" gives lower frequency limit (± 0,2 dB) of 20 Hz. "Fast" also gives an RMS averaging time of 270 ms and a Peak rise time < 50 μs.

"Slow" gives lower frequency limit (± 0,5 dB) of 0,5 Hz. "Slow" gives an RMS averaging time of 3 s and a Peak rise time of < 500 μs.

PEAK HOLD:

"Peak Hold" only functions in the "+ Peak" , "—Peak" and "Max. Peak" modes. The decay rate is 0,05 dB/s with the "Fast" response and 0,005 dB/s with "Slow" response.

"Reset" gives normal (non-hold) operation of the Peak circuits.

2.2. REAR PANEL

DIGITAL OUTPUT:

A 25 pin socket providing the following functions: digital output of voltage value, range setting, Volt or dB mode, sign (+ or —), DC output, + 5 V power to external interface, and provision for external time constants. Connections are given in Table 3.2. The socket accepts McMurdo DB-25 P plug (B & K part number JB 2500).

AC OUTPUT:

BNC socket giving AC signal output voltage. 1,0 V RMS out corresponds to a reading of 1000 on the digital display. Output impedance is 100 Ω to be loaded by at least 2 kΩ.

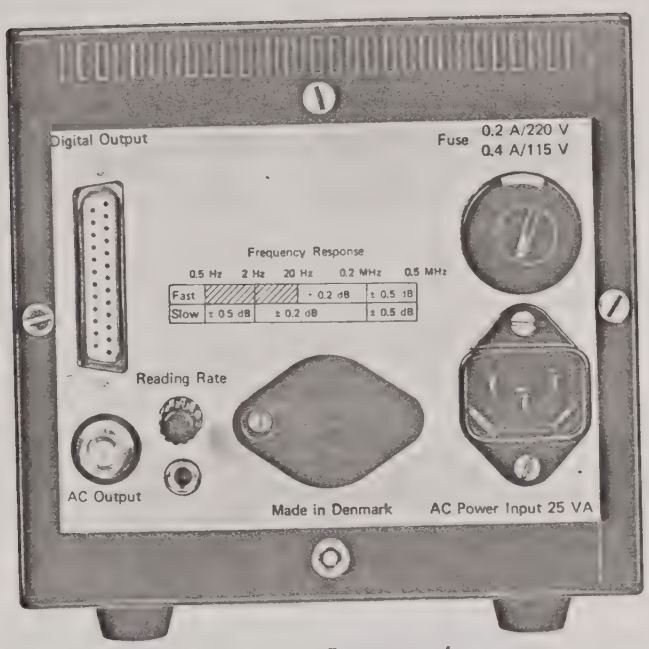

Fig.2.2. Rear panel

READING RATE: A multiturn potentiometer for adjustment of reading rate from approximately 2 readings/s (clockwise) to 10 readings/s (anti-clockwise). May be adjusted for any suitable reading rate. The speed of the autoranging circuit is also affected.

FUSE AND VOLTAGE SELECTOR: Selects correct mains voltage. On delivery the central knob is fitted with a 200 mA fuse for 220 or 240 V operation. For 100, 115, 127 or 150 V operation a 400 mA fuse is also provided.

To remove the fuse, unscrew the black center knob and pull straight out. To change the mains voltage selector, remove the fuse, and then pull the black bush straight out. Replace the bush so its pin fits into the socket corresponding to the appropriate mains voltage.

POWER INPUT: The input power socket accepts power cable AN 0010. The connections to this socket and color code of the cable are shown in Fig.2.3.

CHASSIS GROUND: Connection point for chassis ground.

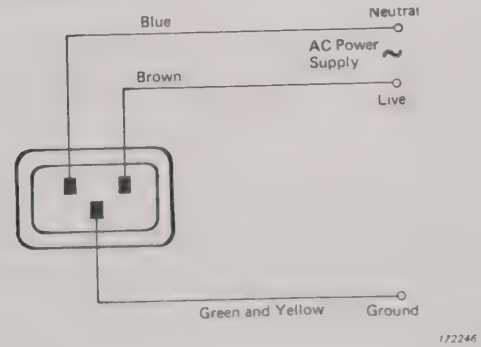

Fig.2.3. Power input socket

3. OPERATION

3.1. PRELIMINARY

3.1.1. Mounting

The 2427 may be used free standing on its four rubber feet or the front end may be raised using the built-in stand (Fig.3.1). For rack mounting, the bottom cover is removed and the 2427 then fits into Rack Mounting Frame KK 0014 which can accommodate 3 instruments the size of the 2427 (such as Phase Meter Type 2971).

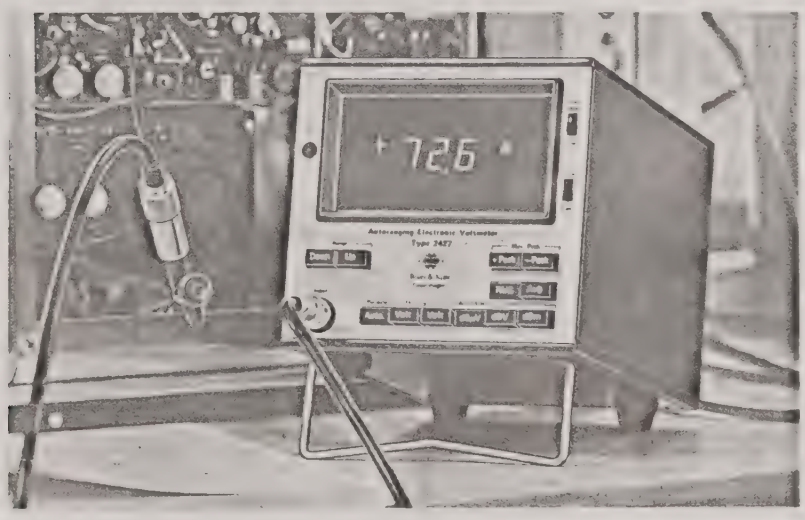

Fig.3.1. 2427 in typical application

3.1.2. Mains Voltage and Fuse Selection

Before use the 2427 should be checked that the proper fuse and mains voltage are selected as described in section 2.2. Operation is from any mains frequency between 50 and 400 Hz with a power consumption of approximately 20 VA.

3.1.3. Grounding Considerations

If the 2427 is used as part of a multiple instrument set-up there is a possibility of ground loops occurring. To assure that no ground loops occur, check the following three points:

1. Connect the signal grounds of all instruments together (automatically done through the screens of the input and output signal cables).

2. Connect both the signal ground to the chassis, and the chassis to the mains ground of one instrument only, preferably the one nearest the measurement point.

3. Make necessary adjustments such that the chassis ground of each of the other instruments is connected to one and only one of the following: 1) mains ground 2) signal ground 3) chassis ground of another instrument which must eventually be connected to mains ground.

If it is necessary to separate the signal ground and chassis of an instrument, this should be done as indicated in its instruction manual. The signal ground and chassis of the 2427 must not be separated.

3.2. AUTORANGING CIRCUITRY

In most cases, the use of the autoranging circuitry is the easiest and fastest. Therefore, in the instructions in the following sections, automatic operation is assumed, except as noted.

The autoranging circuitry operates in both AC and DC voltage modes over the ranges shown in Fig.3.2. To give stable operation, there is a 4 dB overlap between AC ranges and a 10 dB overlap between DC ranges. It is only on signals of very unstable amplitude or in the Peak modes that manual range setting is necessary. The speed of the autoranging circuit depends not only on the READING RATE adjustement, but also the detector and time constants chosen. Fastest autoranging is obtained with "Fast" "Avg." and "Fast" "RMS" settings.

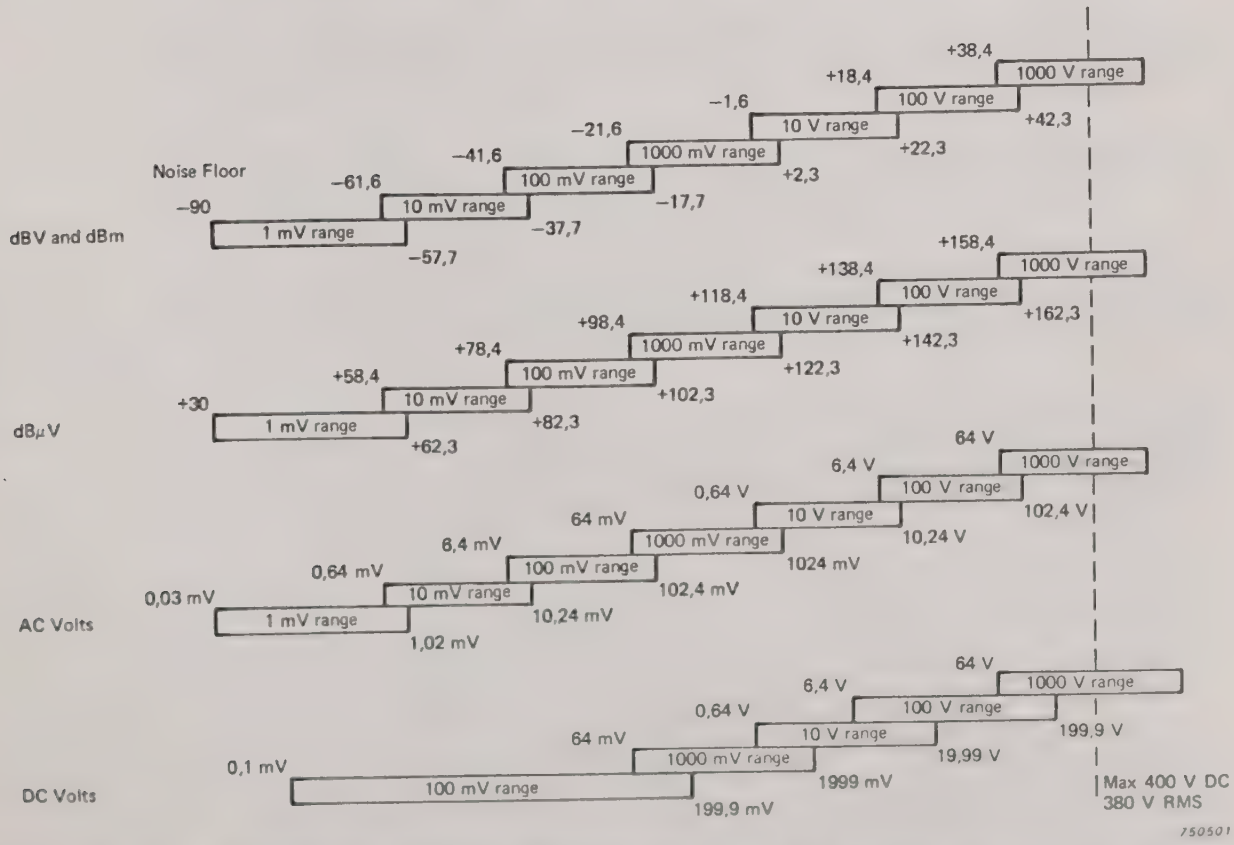

Fig.3.2. Maximum and minimum readings of the 2427 in its different ranges and modes

3.3. AC VOLTAGE MEASUREMENTS

3.3.1. RMS

Select "AC Volt", "RMS" and "Fast". If the reading fluctuates excessively, "Slow" will give a more stable result. To ensure flat low frequency response, "Slow" must also be used at frequencies below 20 Hz.

If the signal also contains a DC voltage component its value should be included to give the true RMS value. This is often the case for a signal not symmetrical with respect to 0 V. For example, a square wave generated by a TTL circuit is symmetrical about + 2,5 V since its value is either 0 or + 5 V. To obtain its true value, both AC and DC components are measured and combined according to

$$V_{RMS} = \sqrt{V_{AC}^2 + V_{DC}^2}$$

3.3.2. Average

Select "AC Volt", "Avg." and "Fast". For fluctuating signals or frequencies below 20 Hz, "Slow" should be used. Since the average value is phase dependent, the "Slow" setting gives the most accurate result since low frequency phase shift is minimized (Fig.4.3).

3.3.3. Peak

The three types of peak measurements made by the 2427 are defined in Fig.3.3. Although the 2427 does not read Peak-to-Peak directly, this value may be found by adding the "+ Peak" and "—Peak" values.

To ensure that clipping of the input signal does not occur, (especially a potential problem with unsymmetrical signals) the appropriate range should be set using "Max. Peak". This range can then be held by selecting "Manual" ranging.

The choice of the appropriate RESPONSE depends on several factors. Since peak values are phase dependent, the "Slow" time constant should give the most accurate value provided the rise time is longer than 500 μs. For shorter rise times down to 50 μs, use "Fast".

Since the 2427 is AC coupled, it must be noted that for unsymmetrical signals, the coupling capacitor will tend to displace the signal such that its average values above and below the zero line are equal. Thus the true peak values will also be offset. This is only the case for longer duration signals and does not occur on short transients. In either case, "Slow" minimizes this offset.

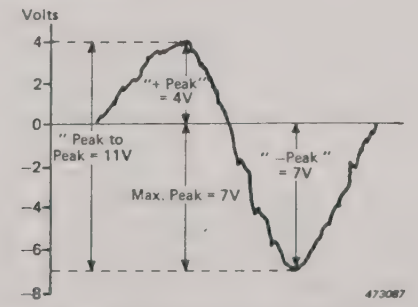

Fig.3.3. Definition of various types of peak measurements

Transient signals

To measure the peak value of a transient signal requires some foreknowledge of the signals's approximate amplitude and rise time. Based on this the 2427 can manually be set to the appropriate range and the proper time constant can be selected. *The autoranging circuitry cannot be used for peak measurements on transients.*

1. Manually select the range including the estimated peak value. (To determine which range the 2427 is in, imagine the display indicating 1000. By noting the position of the decimal point and whether mV or V is indicated the range is readily determined.)

2. Select "Peak Hold". With "Fast" RESPONSE the correct reading will be displayed virtually immediately while with the "Slow" RESPONSE there will be approximately a 15 s delay after the peak has been captured until its value is displayed.

3. To reset the hold circuit, select "Reset" and "Fast". The value on the display only needs to have decayed below the new anticipated value before the next reading may be made. A much faster reset may be achieved by connection of an external reset switch to pins 2 and 12 of the DIGITAL OUTPUT socket on the rear panel.

3.4. DC VOLTAGE MEASUREMENTS

When the 2427 is used for DC measurements, the polarity of the input voltage is automatically shown by the 2427. However, care must be taken not to connect a DC potential to the signal ground of the 2427. Thus both positive and negative voltages may be measured provided that the ground of the voltage source is connected to the ground of the 2427. Floating ground measurements should not be attempted since they may result in a safety hazard.

1. Select the "Auto." mode, "DC Volts", and connect the input signal.

2. When the range has settled, make the reading.

Note that none of the AC related controls such as "Slow" and "Fast" or "Peak Hold" function in the DC mode.

3.5. GENERAL HINTS ON OPERATION

1. The accuracy of the 2427 (or any other voltmeter) is the highest in the upper part of a given range. At lower values in a range the inaccuracy increases significantly (Fig.4.4). Therefore readings near the bottom of a range should be avoided if possible. Fig.3.2 gives the minimum and maximum values of each range of the 2427 in its various modes.

2. From Fig.3.2 it is seen that the AC voltage ranges overlap each other by 4 dB, and for DC the overlap is 10 dB. When a voltage lies in this overlap area it should be measured in the more sensitive of the two ranges including that value. This may be checked by manually downranging the 2427 one range to see whether or not "Out of Range" indication occurs.

3. When operated in the "Manual" mode, the 2427 may be used for AC voltage measurements up to 1999, even though "Out of Range" will be indicated for readings above 1024. Nevertheless, this part of the range can give the highest accuracy and resolution. However, the crest factor capability of the 2427 is reduced from 5 with a reading of 1000 to 2,5 at 1999. Thus low crest factor signals such as sine

and square waves can easily be handled without problems. (In practice, the 2427 can be read all the way up to 2048 although this will be indicated as 048).

4. Although AC voltage measurements can at times be made with "Out of Range" indicated, under no conditions must a dB measurement reading be considered valid with "Out of Range" indicated. This is because the dB conversion is limited to a 24 dB range, the normal width of an AC voltage range.

5. The inherent noise level of the 2427 is approximately 30 μV or 30 dBμV. In the most sensitive AC voltage range this will give a well defined positive error to the measurement. For RMS measurements the resulting reading is the square root of the sum of the squares of the signal and noise voltages, while for Peak measurements, the peak noise and signal voltages add linearly. Typical curves showing noise contributed error are given in Figs.4.5 and 4.6.

   If it is desired to compensate a given reading for internal noise, the noise of the 2427 must be measured with the impedance of the object being measured connected to the input of the 2427. The correction can then be calculated.

6. The "Fast" and "Slow" response settings have no relation to those specified for sound level meters.

3.6. AC OUTPUT

The AC output of 1,0 V RMS (± 2%) corresponds to a reading of 1000. The output impedance of the AC OUTPUT BNC socket on the rear panel is 100 Ω but should be loaded with at least 2 kΩ. The maximum output current is 10 mA and the peak output voltage is 5 V.

Since the AC output is coupled through a 22 μF capacitor, its lower limiting frequency is determined by the loading of the socket. With a 42 kΩ load, for example, the frequency response due to loading will be —0,5 dB at 0,5 Hz and —3 dB at 0,18 Hz, and with a 14 kΩ load (which is in the range of input impedances of Level Recorders 2305 and 2307) the frequency response is —0,5 dB at 1,4 Hz and —3 dB at 0,5 dB. The normal response tolerances of the 2427 and succeeding instruments such as Level Recorders must then be added to these values to give the overall response tolerances. Thus for level recording below 2 Hz more linear response will be obtained if the DC OUTPUT of the 2427 is used.

The gain and dynamic range of the 2427 in various ranges is given in Table 3.1.

Range	1,00 mV	10,00 mV	100,0 mV	1000 mV	10,00 V	100,0 V	1000 V
Gain (dB)	60	40	20	0	– 20	– 40	– 60
S/N ratio* (dB)	> 40	> 60	> 60	> 60	> 60	> 60	> 60

* re 3,16 V RMS out - - unweighted 0,5 Hz to 0,5 MHz

750075

Table 3.1. Gain and signal to noise ratio (Lin. 0,5 Hz — 0,5 MHz) as a function of range

3.7. DC OUTPUT

The DC output of the 2427 gives a DC voltage proportional to the AC voltage reading. Thus its characteristics are determined by the settings of the AC detector and its averaging times. The output impedance is less than 10 Ω and the maximum output current is 10 mA. The output voltage of 1,00 V (± 1%) corresponds to a reading of 1000. The dynamic range of the DC Output is from + 10 dB to —30 dB re a reading of 1000.

The DC output is obtained between pins 1 (+) and 12 (—) of the DIGITAL OUTPUT socket.

The DC output only functions in the AC voltage modes of the 2427, and not in the DC mode.

3.8. EXTERNAL TIME CONSTANTS AND METER RESET

The "Ext. Time Constant" pin of the DIGITAL OUTPUT socket on the rear panel of the 2427 may be used for (1) external selection of averaging times for RMS measurements, (2) external selection of decay times for Peak measurements, and (3) external meter reset. It should be noted that these connections affect only Peak and RMS measurements, and not Average.

3.8.1. External RMS Averaging Time

The averaging time of the RMS circuit will be increased by 1 second for every 2,5 μF capacitance connected across pin 2 (positive) and pin 12 (ground) of the DIGITAL OUTPUT socket. Thus the total averaging time will be equal to the sum of the internal averaging time (0,27 s for "Fast", 3 s for "Slow" RESPONSE) and the external averaging time (1 s per 2,5 μF). For example, for the "Slow" RESPONSE, a 10 μF capacitor will increase the averaging time of the RMS circuit from 3 to 7 s. The use of low leakage capacitors (i. e. **not** electrolytics) is recommended.

3.8.2. External Peak Decay Time

The decay time of the "Peak" circuits of the 2427 may be changed by connection of an external capacitor or resistor to pins 2 and 12 of the DIGITAL OUTPUT socket.

The decay time will be increased by 10 s for every 2,5 μF capacitance connected. Thus the total decay time equals the sum of the internal decay time (2,7 s for "Fast", 30 s for "Slow" RESPONSE) and the external decay time (10 s/2,5 μF). For example, for the "Slow" RESPONSE, a 10 μF capacitor will increase the decay time from 30 to 70 s.

The decay time for peak measurements may also be decreased by connecting a resistor between pins 12 and 2 of the DIGITAL OUTPUT socket. The decay time (τ) is then given by the formula:

$$\tau = \tau_i \frac{R_e}{R_e + R_i}$$

where τ_i is the internal decay time constant of either 2,7 s ("Fast") or 30 s ("Slow"), R_i is equal to 3,9 MΩ and R_e is the value of the external resistance. This relationship is graphed in Fig.3.4 for the "Slow" RESPONSE. It should be noted that accurate Peak measurements can only be guaranteed for decay time constants equal to or greater than 2,7 s.

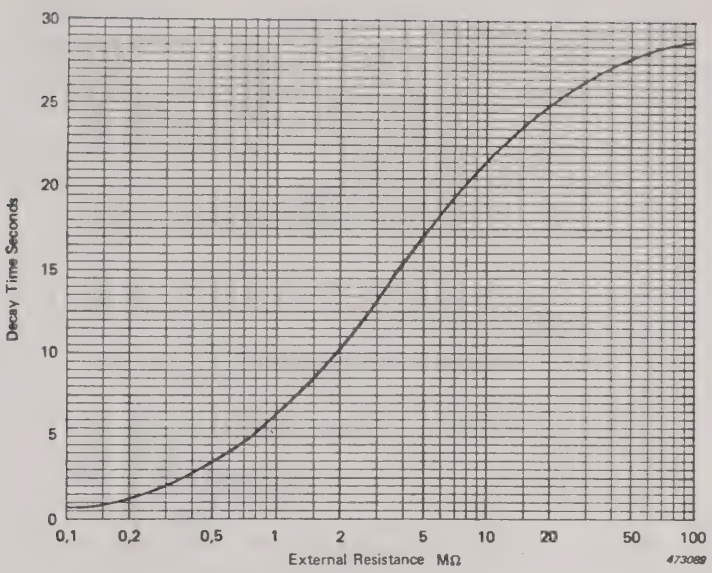

Fig.3.4. Peak decay time for various external resistances and using the "Slow" RESPONSE

3.8.3. Remote Reset

The 2427 may be reset in the Peak or RMS modes by momentarily shorting pins 12 and 2 of the DIGITAL OUTPUT socket. The reset time will be longest in the "Slow" mode, and shortest in the "Fast" RESPONSE mode. If the instrument is in the "Auto." mode, resetting the meter externally will cause the instrument to downrange.

The external reset is different in function than the "Reset" position of the PEAK HOLD switch. The internal "Reset" of the PEAK HOLD switch functions only for the Peak modes and is considerably slower than the external reset which functions in both the Peak and RMS modes, but not for Average.

The external reset may also be used when successive "Peak Hold" measurements are to be made. However, for this application if the signal is not continuous or steady, it is recommended to use the 2427 in the "Man." mode.

3.9. DIGITAL OUTPUT

The DIGITAL OUTPUT socket on the rear panel of the 2427 provides the digital value of the reading displayed by the voltmeter in 1-2-4-8 BCD code. In addition, the sign of the reading is given and whether it is in dB or Volts. Pins 15, 16 and 18 give range information from which the position of the decimal point can be determined. The DATA HOLD (pin 5) and DATA TRANSFER (pin 14) functions make interfacing possible. The DATA HOLD function may also be used to "freeze" the value at any given instant on the display.

A relatively simple interface, Type WA 0122 to Tape Punch Type 6301 or Computer Type 7504 is available from Brüel & Kjær.

The output logic levels of the DIGITAL OUTPUT are TTL compatible and can sink at least four TTL loads of 1,2 mA each. The socket accepts Mc Murdo DB-25P plug (B & K stock number JP 2500) and its pin designations are given in Table 3.2. The timing diagram is given in Fig.4.9.

Pin No.	Function		
19	1st digit		
22	2nd digit	1	
13		2	
21		4	
6		8	
7	3rd digit	1	
8		2	
10		4	
20		8	
11	4th digit	1	
17		2	
4		4	
25		8	
9	+ 5 V		
12	Ground		
23	Sign (+ = "1")		
24	"0" = Volt "1" = dB		
3	Out of Range = "1"		
14	Data Transfer = "0"		
5	Data Hold = "0"		
1	DC Output		
2	External Time Constant		
15	Range	1	
16		2	7 = 1000 V range
18		4	

750030

Table 3.2. DIGITAL OUTPUT pin identification

If remote control of range setting is desired, integrated circuit V 113 on printed circuit board ZD 0064 must be removed from its socket (see Service Instructions for exact location of IC). The IC is an up-down counter type SN 74LS193. Range control is then achieved via the same pins of the DIGITAL OUTPUT that previously gave the range output.

4. DESCRIPTION

This chapter will briefly describe the main circuits of the 2427 in three sections: analog section, dB converter, and ranging/display circuits.

4.1. ANALOG SECTION

4.1.1. AC Amplifiers

The input signal to the 2427 is switched to either the AC or DC sections (Fig.4.1). In the AC mode, the signal is coupled through one of two capacitors selected by the RESPONSE switch giving a lower frequency limit of 20 Hz (± 0,2 dB) in "Fast" and 0,5 Hz (± 0,2 dB) in "Slow". The input impedance of the instrument has been trimmed to be a constant 1 MΩ//60 pF in all AC modes and settings of the input attenuator.

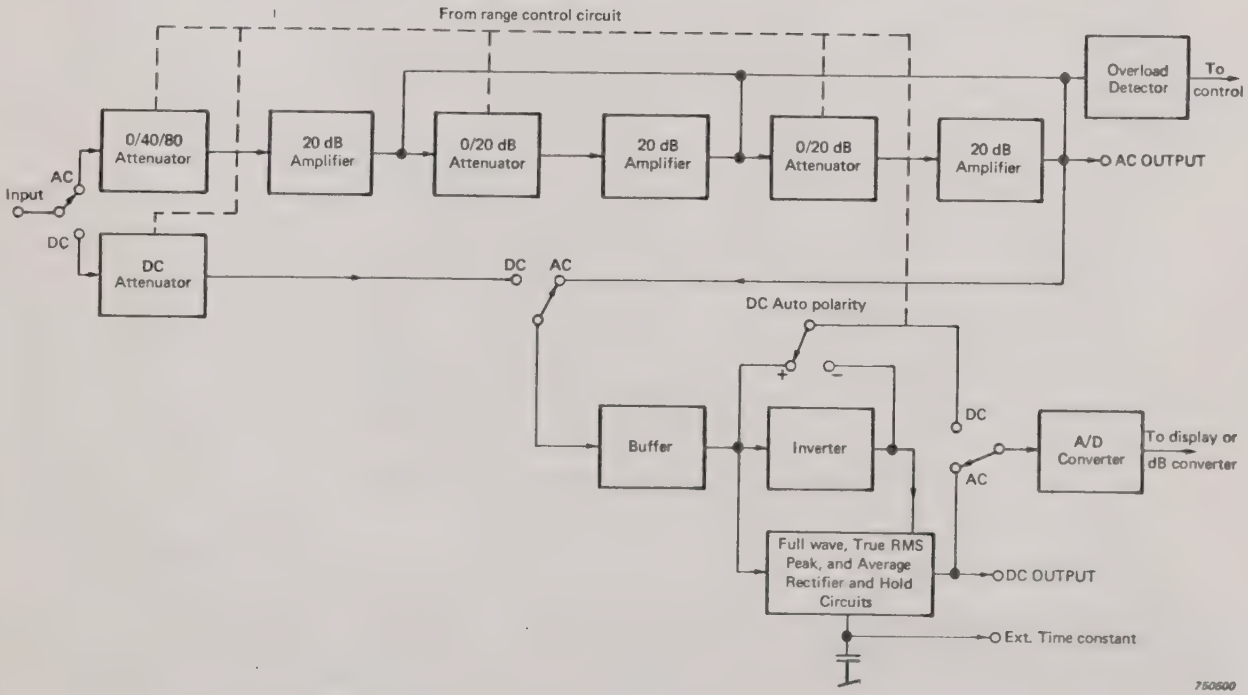

Fig.4.1. Block diagram of analog section

The AC signal path contains three sets of relay switched attenuators alternating with 20 dB amplifiers. The attenuators are controlled by the autoranging logic which selects the appropriate attenuator combinations to give 7 different ranges in steps of 20 dB from 1 mV to 1000 V. Since the gain of all amplifiers is the same in all ranges, the phase response is also held constant from range to range.

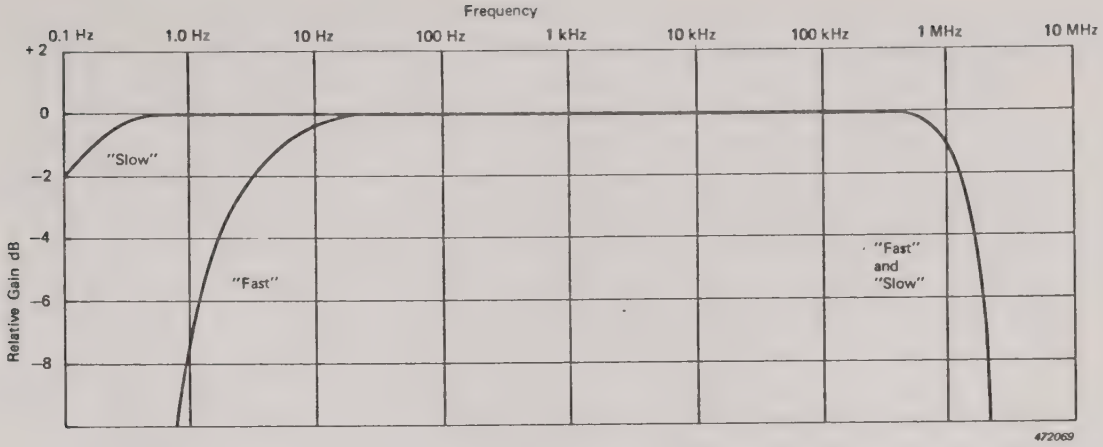

Fig.4.2. Typical frequency response at AC OUTPUT

An overload detector is connected to the output of each 20 dB amplifier and is used as part of the autoranging circuits. The final 20 dB amplifier drives the rectifier circuits and the AC output through a 100 Ω resistor and 22 μF capacitor. Typical phase and amplitude characteristics at the AC OUTPUT socket are given in Fig.4.2 and Fig.4.3.

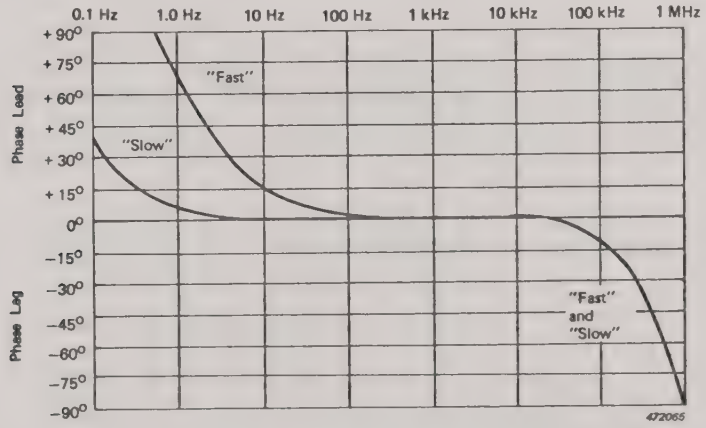

Fig.4.3. Typical phase response at AC OUTPUT

4.1.2. DC Section

In the DC modes, the input signal is attenuated by an appropriate factor of 20 dB. This gives five ranges from 100,0 mV to 1000 V. The input impedance is 1 MΩ in the two lower ranges and 10 MΩ in the three higher ranges. After the input attenuator the correct signal polarity is automatically selected by connection of either the Buffer or Inverter amplifiers to the input of the analog to digital converter.

4.1.3. Rectifier

The same buffer and inverter amplifiers used for DC autopolarity are used in the AC modes to drive the full wave rectifier consisting of two active diodes. For true RMS detection, a circuit whose transfer characteristic approximates a parabola is used. This approx-

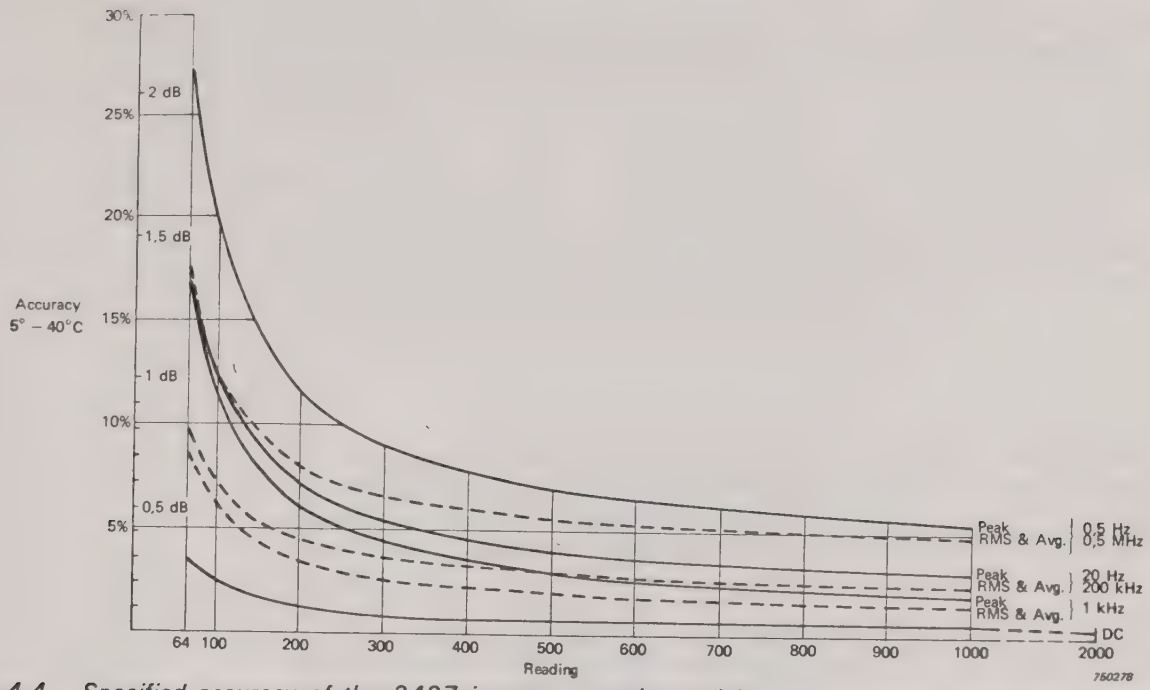

Fig.4.4. Specified accuracy of the 2427 in various modes and frequency ranges. Note the accuracy depends on the actual reading

imation is made by three straight lines generated by three active diodes which switch in at different signal levels. The "Fast" and "Slow" time constants are chosen for negligible ripple at 20 Hz and 0,5 Hz, and must not be confused with the time constants standardized for sound level meters.

The peak rectifier consists of a current generator, capacitor and hold circuit. Average detection is achieved by simple RC averaging of the output of the full wave rectifier.

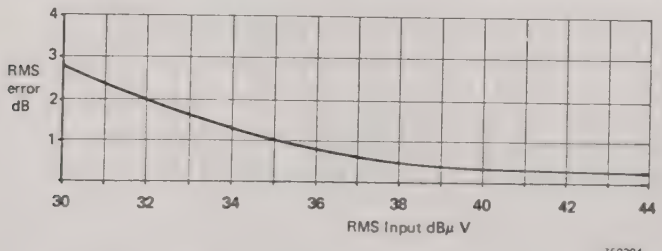

Fig.4.5. Typical influence of internal noise on RMS and average readings

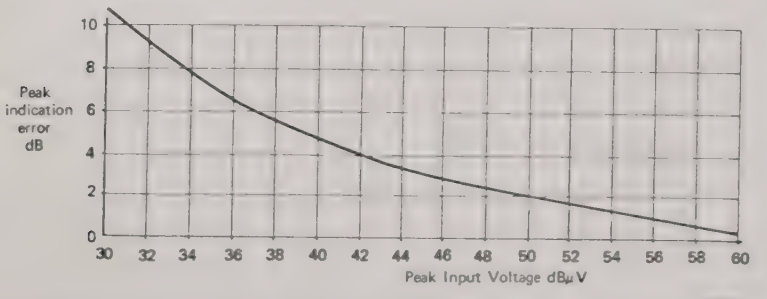

Fig.4.6. Typical influence of internal noise on Peak readings

The accuracy of the various rectifiers as a function of frequency and of display reading is given in Fig.4.4. The influence of inherent instrument noise on the measurement of low level signals is given in Fig.4.5 and Fig.4.6.

4.1.4. A/D Converter

The analog to digital converter is of the integrating type converting the input DC voltage (from the AC rectifiers or DC input) to a serial digital form where the number of pulses in the measuring period is proportional to the voltage. The converter has high accuracy and stability and excellent rejection of normal mode signals.

4.2. dB CONVERTER

The dB converter takes the serial input signal from the A/D converter and converts it to parallel form to permit access of the dB value which is stored in a read only memory (ROM). The output of the ROM is reconverted to serial form and passed on to the display circuits. The dB converter operates over a 24,1 dB range corresponding to 64 to 1024 input pulses.

The input pulses are divided by an appropriate factor of 1, 2, 4 or 8 so that the dynamic range necessary in the dB table is only 6 dB instead of 24 dB. This results in significant economies in the size of the read only memory.

For voltages with only two digits resolution (64 to 99) a change of one in the last digit of the voltage value, may in a few cases result in a change of 0,2 dB in the decibel value. This is simply due to round off to the nearest 0,1 dB and explains the presence of a few 0,2 dB steps in the lower 4 dB of any given range. This can simply be avoided by downranging 20 dB since the ranges overlap by 4 dB. At higher voltages in a given range, the voltage resolution is more than adequate to give 0,1 dB resolution.

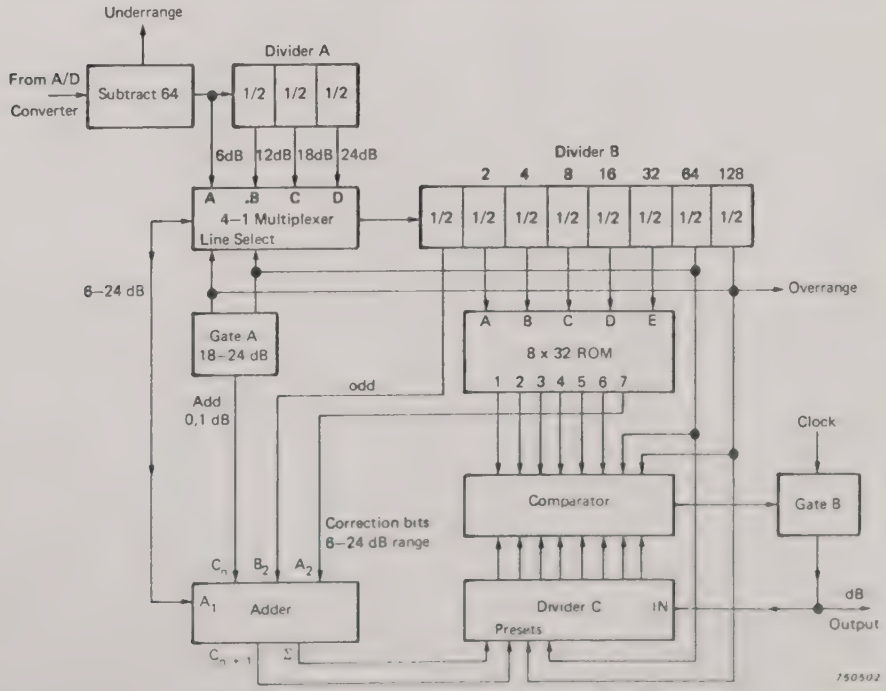

Fig.4.7. Block diagram of dB converter

4.3. RANGING/DISPLAY SECTION

As seen in Fig.4.8, the output of the A/D converter or dB converter is fed to the display counters and drivers. In the dB modes, the counters are preset to give addition of appropriate factors of 20 dB. This information is stored in a ROM which presets the counter to an appropriate value depending on the status of the front panel switches and the range of the instrument. However, the correction of 2,2 dB for correction of dBm to dBV values is achieved by analog means, a simple voltage divider ahead of the A/D converter.

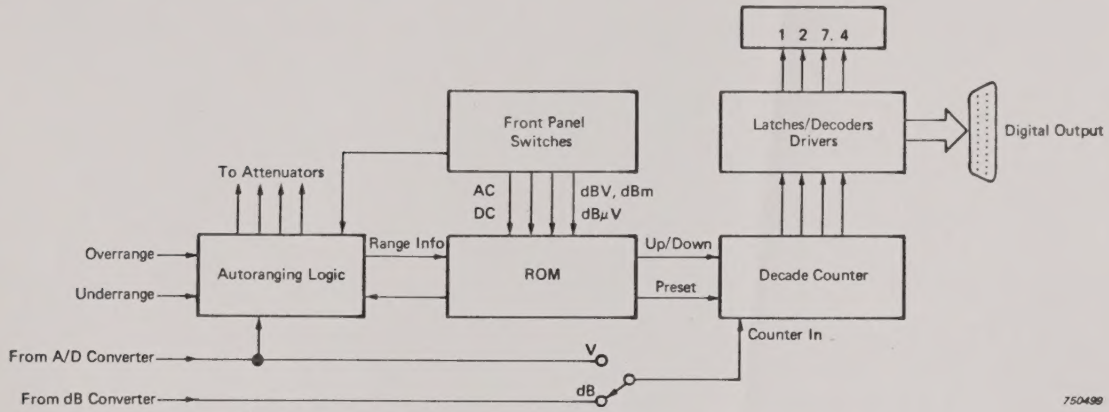

Fig.4.8. Block diagram of ranging and display circuits

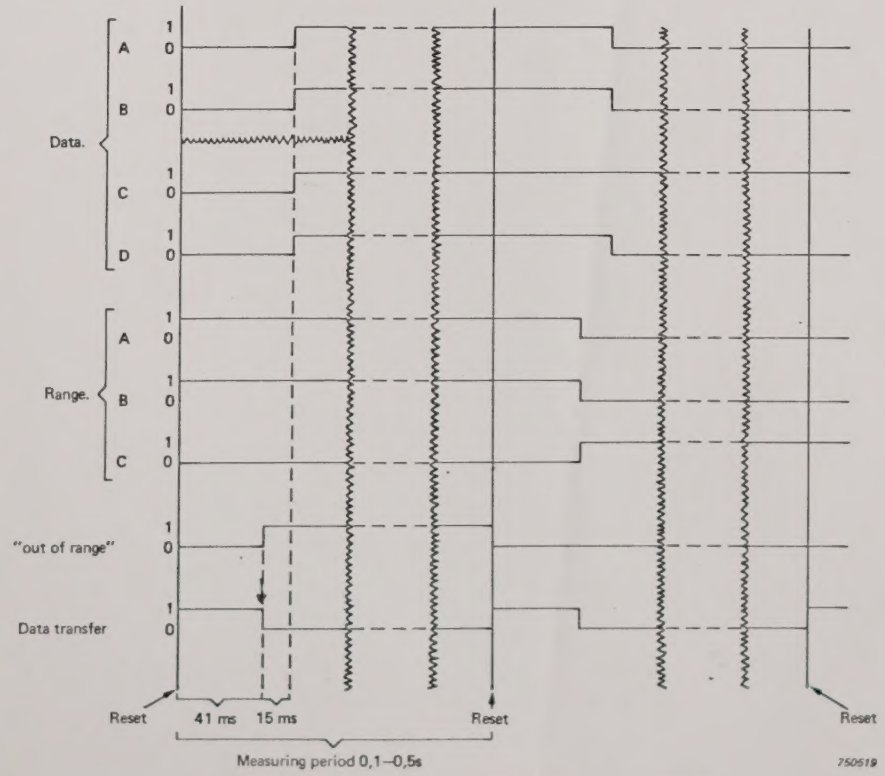

Fig.4.9. Timing diagram of DIGITAL OUTPUT

In the AC voltage modes, overrange and underrange information comes from the dB converter. The input circuit which subtracts 64 pulses gives underrange indication, while overflow of Divider B (Fig.4.7) indicates overrange (> 1024). Underrange in the DC mode is achieved similarly, but overrange detection is in a separate circuit since the maximum DC voltage count is 1999. The overrange and underrange signals trigger an up/down counter which generates the appropriate binary codes for control of the relay switched attenuators.

The DIGITAL OUTPUT socket gives the information indicated in Table 3.2. The timing diagram is given in Fig.4.9.